Health Promotion and Chronic Disease Prevention in Canada

Research, Policy and Practice

Volume 37 · Number 11 · November 2017

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ISSN 2368-738X
Pub. 160268
Journal_HPCDP-Revue_PSPMC@phac-aspc.gc.ca

Également disponible en français sous le titre : *Promotion de la santé et prévention des maladies chroniques au Canada : Recherche, politiques et pratiques*

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Public Health Agency of Canada | Agence de la santé publique du Canada

Canada

https://doi.org/10.24095/hpcdp.37.11.01

Adherence to the 24-Hour Movement Guidelines among 10- to 17-year-old Canadians

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Abstract

Introduction: The *Canadian 24-Hour Movement Guidelines for Children and Youth* were released in 2016. They contain specific recommendations on the daily time that 5- to 17-year-olds should devote to moderate-to-vigorous physical activity, recreational screen time, and sleep. The objective of this study was to estimate the proportion of Canadians aged 10 to 17 years that meet the recommendations contained within the *24-Hour Movement Guidelines for Children and Youth*.

Methods: A nationally representative sample of 22 115 young people was examined. Movement behaviour data were self-reported. Adherence to the guideline recommendations were based on the following: accumulation of at least 60 minutes per day of moderate-to-vigorous physical activity, no more than 2 hours per day of recreational screen time, and 9 to 11 hours/night of uninterrupted sleep for those aged 10 to 13 years or 8 to 10 hours/night for those aged 14 to 17 years.

Results: Only 3% of the sample met all three of the key recommendations contained in the guidelines. Twenty-five percent met two of the recommendations, 51% met one of the recommendations, and 21% met none of the three recommendations. More children and youth met recommendations for sleep duration (66%) than for moderate-to-vigorous physical activity (35%) and screen time (8%).

Conclusion: A small minority (< 3%) of Canadians aged 10 to 17 years met all three of the key recommendations contained in the *24-Hour Movement Guidelines for Children and Youth*.

Keywords: physical activity, screen time, sleep, child, youth

Highlights

- This study estimated the proportion of Canadians aged 10 to 17 years that meet the recommendations contained within the *Canadian 24-hour Movement Guidelines for Children and Youth*.
- Only 3% met all three of the key recommendations for moderate-to-vigorous physical activity, screen time, and sleep contained in the guidelines.
- More children and youth met recommendations for sleep duration (66%) than for moderate-to-vigorous physical activity (35%) and screen time (8%).

Introduction

A lack of physical activity,[1,2] excessive sedentary behaviour, particularly recreational screen time,[3,4] and insufficient sleep[5,6] are associated with an assortment of physical, mental, and social health indicators among school-aged children and youth. Canada had separate and distinct public health guidelines for physical activity[7] and sedentary behaviour.[8] The U.S. National Sleep Foundation developed sleep duration guidelines,[9] and within Canada these guidelines were endorsed by pediatric sleep health experts.[5] The existence of these three distinct guidelines demonstrates that physical activity, sedentary behaviour, and sleep have historically been considered separate and independent from each other. Nonetheless, researchers are beginning to recognize that these three behaviours are codependent and should be considered simultaneously.[10-13] Because these three behaviours are mutually exclusive and time spent in these behaviours across a day must collectively account for the entire 24-hour period, time spent in physical activity, sedentary behaviour, and sleep are codependent. In other words, time spent in one behaviour necessarily displaces time spent in at least one of the remaining behaviours.

In recognition of the codependence of physical activity, sedentary behaviour, and sleep, a large group of researchers and knowledge users recently developed the "*Canadian 24-Hour Movement Guidelines for Children and Youth: An integration of physical activity, sedentary behaviour and sleep*".[14] Hereafter, these guidelines are referred to as the "24-Hour Movement Guidelines". The 24-Hour Movement Guidelines were developed under the leadership of the Canadian Society for Exercise Physiology with additional support and endorsement by the Children's Hospital of Eastern Ontario, the Conference Board of Canada, the Public Health Agency of Canada, and ParticipACTION. They contain specific recommendations on the time that 5- to 17-year-olds should devote to moderate-to-vigorous physical activity (MVPA of ≥60 minutes/day), recreational screen time (≤2 hours/day), and sleep (9 to 11 hours/day for 5- to 13-year-olds, and 8 to 10 hours/day for 14- to 17-year-olds) to support healthy development. Adhering to each of the recommendations within the guidelines is associated with a variety of health outcomes including body

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composition, physical fitness, academic achievement and cognition, emotional regulation, pro-social behaviours, cardiovascular and metabolic health, and overall quality of life. In setting these recommendations, the 24-Hour Movement Guidelines establish measureable targets for surveillance and provide guidance to health-care professionals, researchers, decision makers, and the general public. The 24-Hour Movement Guidelines also highlight to these groups that focusing on a single behaviour is an out-of-date approach, because a person doing well with that behaviour can still have an unhealthy movement behaviour profile. For instance, a child with sufficient MVPA but too much screen time and inadequate sleep does not have an ideal movement behaviour profile.

Now that the new 24-Hour Movement Guidelines have been released, it is important to have timely descriptive information on the proportion of Canadian children and youth who simultaneously achieve all of the movement behaviour recommendations. This information could be used to inform the development of programs and policies to promote healthy movement behaviours. Therefore, the primary objective of this study is to estimate the proportion of Canadian children and youth who simultaneously meet all of the movement behaviour recommendations contained within the 24-Hour Movement Guidelines. The secondary objectives are to estimate the proportion who meet the individual guideline recommendations, as well as the different intermediate combinations of the recommendations (e.g. meet recommendations for physical activity and sleep but not screen time). We had the opportunity to study these objectives using the *Health Behaviour in School-Aged Children (HBSC)* study, a large and representative sample of Canadians in grades 6 to 10.

Methods

Study sample and design

This study is based on Canadian records from the 2013/14 cycle of the HBSC. The HBSC is a World Health Organization (WHO) collaborative cross-national study of students in grades 6 to 10.[15, 16] The 2013/14 Canadian HBSC followed the international sampling protocol. In doing so, classes within 349 schools were selected using a weighted probability technique that ensured proportional representation based on location, language, religion, and community size. Students enrolled in special needs, on-reserve, or non-publicly funded schools were excluded; collectively, they represent < 7% of young Canadians.[16] Seventy-seven percent of those originally selected participated, which involved completing a 45-minute long questionnaire. Consent was obtained from students, parents/guardians, individual schools, and school boards. The study received ethics approval from the Queen's University General Research Ethics Board (Research Ethics Committee reference file #6010236).

The items included in the HBSC questionnaire are continuously developed, validated, and pilot tested by the HBSC international network and in Canada by the Canadian HBSC investigators.[15,16] In most instances the findings of these validity and pilot studies are not published. However, to comply with the international HBSC protocol, there needs to be evidence that the questionnaire item has acceptable psychometric properties and that it is well-understood by grade 6-10 students.

A small proportion (n = 606, 2.0%) of the original sample of 30 153 students completed a condensed questionnaire that did not include the sleep items. An additional 369 (1.2%) were outside of the target age range (e.g. a grade 12 student taking a grade 10 class). Thus, the eligible sample for the present study consisted of 29 178 children and youth aged 10 to 17 years. Of these, 67 (0.2%) were excluded because of missing data on age or gender. An additional 4429 (15.1%) were excluded because of missing data on one or more of the sleep-time items, or because their weekday and/or weekend sleep duration was greater than three standard deviations from the mean, as we assumed their abnormal data reflected recording errors. An additional 1772 (6.1%) were excluded because they did not respond to one or more of the physical activity items and 975 (3.3%) were excluded because they did not respond to one or more of the screen-time items. The final sample size for this study was 22 115. A comparison of the final sample to the 7063 participants that were excluded from the statistical analyses is provided in Table 1. The relative differences between the included and excluded groups were within 10% for all of the demographic (e.g. age, gender, race), geographic (e.g. province/territory, municipality size), and movement behaviour (e.g. sleep, MVPA, screen time) variables.

24-Hour Movement Behaviour Guidelines

The paper describing the 24-Hour Movement Guidelines and their development provides instructions on how these guidelines should be interpreted for surveillance purposes.[14] These instructions indicate that for minimal inclusion in guideline surveillance, the following three conditions be met: 1) 9 to 11 hours of uninterrupted sleep per night for those aged 5 to 13 years and 8 to 10 hours per night for those aged 14 to 17 years; 2) accumulation of at least 60 minutes per day of MVPA involving a variety of aerobic activities; and 3) no more than 2 hours per day of recreational screen time. The recommendations indicate that each of the aforementioned three conditions should be met when averaging daily time across all 7 days of the week.

Sleep duration

Participants were asked to report the typical time during the past week that they turned out the lights to go to sleep and woke up in the morning, separately for weekdays and weekends. Based on this information, each participant's average nightly sleep duration was calculated and we determined whether or not participants had a sleep duration that met the recommended range (9 to 11 hours/night for 6- to 13-year-olds, and 8 to 10 hours/night for 14- to 17-year-olds).[14] Sleep durations falling even one minute outside of these ranges were classified as not meeting the guidelines. Results from a validity study indicate that estimates of youths' average nightly sleep duration calculated from self-reported bed times and wake up times are comparable to the average objectively measured sleep duration obtained using actigraphy (471 vs. 461 minutes/night, respectively).[17]

Moderate-to-vigorous physical activity

Children and youth accumulate their MVPA by participating in physical activities in class time at school (e.g. physical education class), organized sports and programs in their free time, active outdoor play in their free time, and active transportation (e.g. walking or bicycling to school).[18] The amount of MVPA performed in class time at school and in free time outside of school, including organized sports and programs and active outdoor

TABLE 1
Descriptive characteristics of 2013/14 HBSC participants according to whether they were included or excluded from the statistical analyses

Characteristic	Included participants (N = 22 115)		Excluded participants (N = 7063)	
	n (95% CI)		n (95% CI)	
Age, mean	14.1	(13.9–14.3)	14.1	(13.9–14.3)
Gender, % female	52.8	(51.2–54.5)	45.2	(42.7–47.4)
Race, % white	76.0	(71.6–80.5)	70.7	(65.3–76.0)
Immigration status, % born in Canada	81.3	(79.2–83.4)	77.5	(74.5–80.4)
Perceived family wealth, % not well off	8.7	(8.0–9.3)	9.0	(8.0–10.1)
Region of Canada				
West (BC, AB), %	24.7	(16.1–33.3)	23.5	(13.9–33.2)
Prairies (SK, MB), %	7.8	(4.3–11.3)	7.2	(3.7–10.7)
Ontario, %	42.8	(33.2–52.5)	38.6	(28.3–48.9)
Quebec, %	19.1	(8.7–29.5)	21.3	(10.0–32.6)
Maritimes (NS, NB, PE), %	3.4	(1.7–5.1)	7.4	(1.2–13.6)
Territories (NT, YU, NU), %	0.5	(0.3–0.7)	0.6	(0.3–0.8)
Type of municipality				
Rural (<1000), %	4.1	(1.2–7.1)	3.3	(1.2–5.5)
Small centre (1000-29 999), %	36.7	(26.5–46.8)	39.9	(28.7–51.0)
Medium centre (30 000-99 999), %	18.7	(11.2–26.3)	19.0	(10.1–28.0)
Large centre (100 000-499 999), %	25.2	(16.9–33.5)	21.8	(13.3–30.2)
Metropolitan (≥500 000), %	15.3	(8.6–22.0)	15.9	(7.5–24.4)
Movement behaviours				
Sleep duration, hours/day	9.0	(8.9–9.0)	9.0	(8.9–9.1)
Moderate-to-vigorous physical activity, hours/week	5.6	(5.4–5.8)	5.8	(5.6–6.1)
Screen time, hours/day	7.5	(7.3–7.7)	8.1	(7.8–8.5)

Abbreviations: CI, confidence interval; HBSC, *Health-Behaviour in School-Aged Children* study.

Note: Data presented as mean (95% CI) for continuous variables and prevalence (95% CI) for categorical variables.

play, were assessed with the following two items: *"About how many hours a week do you usually take part in physical activity that makes you out of breath or warmer than usual in your class time at school?"* and *"Outside of school hours: How many hours a week do you usually exercise in your free time so much that you get out of breath or sweat?"*. Response options to these two items were: *"none at all"*; *"about ½ hour"*; *"about 1 hour"*; *"about 3 hours"*; *"about 4 hours"*; *"about 5 hours"*; *"about 6 hours"* and *"about 7 hours"*. The amount of time spent in active transportation was assessed with the following items: *"On a typical day, the main part of your journey to school is made by...."* and *"How long does it usually take you to travel to school from your home"*. Participants who did not select the *"walking"* or *"bicycling"* options for school travel mode were deemed to have accumulated no active transportation. For those who selected the *"walking"* or *"bicycling"* options, their weekly active transportation was determined by multiplying the school travel time by two (to account for trips to and from school) and then by five (as there are five school days/week). We then added time spent in MVPA in active transportation, class time at school, and in free time outside of school, and then divided these times by 7 to obtain their average daily MVPA. Based on this total, participants were categorized into those who did (≥ 60 minutes/day on average) and those who did not (< 60 minutes/day on average) meet the MVPA recommendation.

Test-retest reliability analyses indicate there is ≥ 0.80 agreement between repeated responses to the HBSC active transportation item.[19] The agreement between repeated responses to the class time at school and free time outside of school physical activity items ranges from 67% to 85% across different gender and grade groups.[20] The test-retest reliability of self-reported organized sport participation is also high (*Kappa* = 0.84).[21]

It is important to note that the recommendation to look at the daily average for MVPA is different from how previous Canadian surveillance studies examined this behaviour, although the recommendation has not changed since the release of the previous physical activity guidelines.[7] Most studies have assessed adherence to the MVPA recommendation based on the achievement of 60 minutes of MVPA on 6 or all 7 days of the week,[16, 22, 23] as per Canadian and World Health Organization recommendations at the time of the physical activity guideline release.[7, 24]

Screen time

The amount of time spent watching entertainment on a screen, playing sedentary video games and using electronic screen devices for other purposes were determined using the following items: *"How many hours a day, in your free time, do you usually spend watching TV, videos (including YouTube or similar services), DVDs, and other entertainment on a screen?"*, *"How many hours a day, in your free time, do you usually spend playing games on a computer, games console, tablet (like iPad), smartphone or other electronic device (not including moving or fitness games)?"* and *"How many hours a day, in your free time, do you usually spend using electronic devices such as computers, tablets (like iPad) or smartphones for other purposes (e.g., homework, emailing, tweeting, Facebook, chatting, surfing the internet)?"* For each question, the response options were *"none at all"*; *"about half an hour a day"*; *"about 1 hour a day"*; *"about 2 hours a day"*; *"about 3 hours a day"*; *"about 4 hours a day"*; *"about 5 hours a day"*; *"about 6 hours a day"*; or *"about 7 or more hours a day"*. Questions were asked for both weekday and weekend use. There is a moderate-to-high agreement between repeated responses to these HBSC screen-time questions with Kappa coefficients ranging from 0.68 to 0.82.[25] Average daily screen time was

calculated and participants were categorized into those who did (≤ 2.0 hours/day) and those who did not (> 2.0 hours/day) meet the screen-time recommendation.

Age and gender categories

Gender (n = 10 480 boys, 11 664 girls) and age comparisons were made. For age comparisons, participants were grouped into 10- to 13-year-olds (n = 10 243) and 14- to 17-year-olds (n = 11 901) categories. The cut-point that differentiated the younger and older age groups was selected to correspond with the change in sleep duration recommendations from 13 to 14 years of age.[14]

Statistical analysis

Statistical analyses were conducted in SAS version 9.4 (Cary, NC, USA). Proc survey procedures with the weight and cluster options were used to account for the sample weights and the clustered (by classroom) nature of the survey. The prevalence of participants adhering to the 24-Hour Movement Guidelines, different intermediate combinations of the guideline recommendations, and different number of guideline recommendations were calculated. Gender and age group differences were determined using the Rao-Scott chi-square test which allowed us to control for clustering at the school level. A p-value of < 0.05 was used to denote statistical significance.

Results

A description of the sample that was included in the statistical analyses is provided in Table 1. Additional information on the proportion meeting sleep, MVPA, and screen-time recommendations are in Table 2. Of the representative sample of 10- to 17-year-olds studied, 66% met the sleep duration recommendation, 35% met the MVPA recommendation, and 8% met the screen-time recommendation components of the guidelines (Table 2). The proportion of boys and girls meeting the sleep duration recommendation was not different; however, more boys than girls met the recommendation of 60 minutes/day of MVPA. Conversely, more girls than boys met the screen-time recommendation of ≤ 2 hours /day. The proportion of 10- to 13-year-olds and 14- to 17-year-olds meeting the sleep duration or the MVPA recommendations did not differ; however, a greater proportion of 10- to 13-year-olds met the screen-time recommendation.

TABLE 2
Proportion of 10- to 17-year-olds that met the individual components of the 24-Hour Movement Guidelines

Guideline component	All participants (N = 22 115) % (95% CI)	Gender groups		Age groups	
		Boys (n = 10 465) % (95% CI)	Girls (n = 11 650) % (95% CI)	10- to 13-year-olds (n =10 236) % (95% CI)	14- to 17-year-olds (n = 11 879) % (95% CI)
Sleep duration	66.2 (64.7–67.7)	65.8 (64.1–67.5)	66.6 (64.7–68.5)	64.5 (62.4–66.6)	67.7 (65.9–69.5)
Physical activity	35.4 (32.8–38.0)	41.6 (38.7–44.6)	29.8 (27.1–32.6)*	36.0 (33.7–38.2)	34.9 (31.2–38.9)
Screen time	8.1 (7.1–9.0)	7.1 (6.1–8.1)	8.9 (7.7–10.1)*	11.6 (10.3–12.9)	5.0 (4.3–5.8)**

Abbreviations: 24-Hour Movement Guidelines, *Canadian 24-Hour Movement Guidelines for Children and Youth*; CI, confidence interval.

Note: Data presented as prevalence (95% CI).

* Significantly different from boys ($p < 0.05$).

** Significantly different from 10- to 13-year-olds ($p < 0.05$).

As shown in Table 3, 21% of the sample did not meet any of the sleep duration, MVPA, or screen-time recommendations. This proportion was higher in girls than boys but did not differ by age. Approximately 51% met one of the three recommendations, 25% met two of the recommendations, and less than 3% met all three recommendations and adhered to the 24-Hour Movement Guidelines.

Table 4 provides information on the proportion who met different intermediate combinations of the guideline recommendations. Less than 5% met the recommendations for screen time only, the sleep duration and screen-time combination, and the MVPA and screen time combination. The proportion meeting recommendations for sleep only, MVPA only, and the combination of sleep and MVPA all exceeded 10%.

Discussion

This study determined the proportion of Canadians aged 10 to 17 years that meet the new 24-Hour Movement Guidelines. A small minority (< 3%) met all three of

TABLE 3
Proportion of 10- to 17-year-olds that met different numbers of the three specific recommendations included in the 24-Hour Movement Guidelines

# of guideline recommendations met	All participants (N = 22 115) % (95% CI)	Gender groups		Age groups	
		Boys (n = 10 465) % (95% CI)	Girls (n = 11 650) % (95% CI)	10- to 13-year-olds (n = 10 236) % (95% CI)	14- to 17-years-olds (n = 11 879) % (95% CI)
None	20.9 (19.5–22.3)	18.8 (17.3–20.4)	22.9 (21.1–24.4)*	21.2 (19.4–23.0)	20.7 (19.0–22.3)
One	51.1 (49.4–52.9)	50.3 (48.5–52.0)	51.9 (49.6–54.2)	49.3 (47.6–50.9)	52.7 (50.4–55.1)**
Two	25.3 (23.5–27.2)	28.4 (26.1–30.8)	22.6 (20.7–24.4)*	25.9 (24.2–27.6)	24.8 (22.1–27.6)
All three	2.6 (2.2–3.0)	2.5 (2.0–3.0)	2.7 (2.2–3.3)	3.7 (3.0–4.3)	1.7 (1.3–2.2)**

Abbreviations: 24-Hour Movement Guidelines, *Canadian 24-Hour Movement Guidelines for Children and Youth*; CI, confidence interval.

Note: Data presented as prevalence (95% CI).

* Significantly different from boys ($p < 0.05$).

** Significantly different from 10- to 13-year-olds ($p < 0.05$).

TABLE 4
Proportion of 10- to 17-year-olds that met different combinations of the three specific recommendations included in the 24-Hour Movement Guidelines

Combination of guideline recommendations met	All participants (N = 22 115)	Gender groups		Age groups	
		Boys (n = 10 465)	Girls (n = 11 650)	10- to 13-year-olds (n = 10 236)	14- to 17-years-olds (n = 11 879)
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
None	20.9 (19.5–22.3)	18.8 (17.3–20.4)	22.7 (21.1–24.4)*	21.1 (19.4–23.0)	20.7 (19.0–22.3)
Sleep duration only	39.2 (36.9–41.4)	35.9 (33.7–38.1)	42.1 (39.2–45.0)*	36.1 (34.3–37.9)	41.8 (38.6–45.0)**
Physical activity only	10.7 (9.7–11.6)	13.2 (12.0–14.4)	8.4 (7.3–9.4)*	11.4 (10.4–12.5)	10.0 (8.7–11.3)
Screen time only	1.3 (1.0–1.5)	1.1 (0.8–1.4)	1.4 (1.1–1.8)	1.7 (1.3–2.1)	1.0 (0.7–1.2)**
Sleep duration + physical activity	21.8 (19.3–23.0)	24.9 (22.4–27.3)	17.9 (16.1–19.6)*	19.6 (18.9–21.3)	22.5 (19.8–25.2)**
Sleep duration + screen time	3.2 (2.3–3.7)	2.5 (2.0–3.0)	3.9 (3.2–4.5)*	5.0 (4.3–5.9)	1.7 (1.4–2.0)**
Physical activity + screen time	0.9 (0.7–1.1)	1.0 (0.8–1.3)	0.8 (0.6–1.0)	1.2 (0.9–1.5)	0.7 (0.4–0.9)**
All three	2.6 (2.2–3.0)	2.5 (2.0–3.0)	2.7 (2.2–3.3)	3.7 (3.0–4.3)	1.7 (1.3–2.2)**

Abbreviations: 24-Hour Movement Guidelines, *Canadian 24-Hour Movement Guidelines for Children and Youth*; CI, confidence interval.

Note: Data presented as prevalence (95% CI).

* Significantly different from boys ($p < 0.05$).

** Significantly different from 10- to 13-year-olds ($p < 0.05$).

the key recommendations contained in the guidelines. Based on self-reported data, more children and youth meet recommendations for sleep duration (66%) than for MVPA (35%) and screen time (8%).

The 24-Hour Movement Guidelines have just been released and these are the first public health guidelines that integrate multiple movement behaviours. Therefore, no previous surveillance studies have examined the simultaneous adherence to sleep, physical activity, and screen-time recommendations. Therefore, the results of the present study are novel and they cannot be directly compared to previous studies. With that being said, previous studies based on nationally representative samples of young Canadians have examined adherence to the individual recommendations within the guidelines. Some of these results are discussed below.

The previous Canadian physical activity guidelines for school-aged children and youth recommended 60 minutes of MVPA on a daily basis.[7] This is identical to the MVPA recommendation contained within the new 24-Hour Movement Guidelines. For surveillance purposes, researchers have historically required that children and youth obtain 60 minutes of MVPA on six or all seven days of the week to be considered physically active.[23] A paradigm shift in the new 24-Hour Movement Guidelines (and the surveillance recommendations contained within these guidelines) is the notion that for surveillance purposes daily MVPA should be averaged across a week.[14] Self-reported data from the 2001/02, 2005/06, 2009/10, and 2013/14 cycles of the Canadian HBSC study suggested that 18% to 20% of grades 6 to 10 students met the 60 minute target on all seven days of the week.[16] The shift to an average recognizes that there is day-to-day variability in a young person's MVPA and other movement behaviours, and that ultimately it is more important to accumulate a sufficient volume of MVPA over a week than it is to require that a specific volume of MVPA be accumulated each and every day.[1,2]

Previous Canadian sedentary behaviour guidelines for school-aged children and youth recommended a maximum of 2 hours per day of recreational screen time.[26] This is identical to the screen-time recommendation contained within the new 24-Hour Movement Guidelines. Previous surveillance studies on screen time in Canada have traditionally considered the average daily screen-time level and did not require the 2-hour target be met on most or all days of the week. That approach is consistent with the surveillance recommendations for screen time that are part of the new 24-Hour Movement Guidelines.[14] Findings from the 2009/10 cycle of the HBSC indicated that 19% of grades 6 to 10 Canadians met the screen-time recommendation at that time,[16] which is twice as high as the 8% prevalence level reported here based on the 2013/14 HBSC. Substantial changes were made to the questionnaire items that assessed screen time between the 2009/10 and 2013/14 HBSC cycles, which may have in part contributed to the different prevalence estimates. Specifically, the questionnaire items changed to reflect changes to screen-time technology such as the use of tablet computers to watch television programs, inclusion of social media on the computer questions, inclusion of Blu-ray discs in addition to DVDs for movie watching, inclusion of YouTube and similar videos to program watching, and the exclusion of active video games when responding to the video-game question.

There is a limited amount of surveillance data on sleep duration. The only comparable Canadian data that we know of are from the 2012/13 *Canadian Health Measures Survey*. Findings from that survey suggested that 18% of 5- to 11-year-olds and 33% of 12- to 17-year-olds did not obtain adequate sleep.[27] Adequate sleep was defined as 10 to 13 hours/day for 5-year-olds, 9 to 11 hours/day for 6- to 13-year-olds, and 8 to 10 hours/night for 14- to 17-year-olds. These findings are similar to those reported here, which suggest that 35% of 10- to 13-year-olds and 32% of 14- to 17-year-olds did not get the appropriate amount of sleep.

A finding in this paper is that a very small proportion (< 3%) of Canadians aged 10 to 16 years do well in all of the movement

behaviours that comprise Canada's new *24-Hour Movement Guidelines for Children and Youth*. An important lesson learned is that focusing on a single movement behaviour in isolation does not capture the extent of the movement crisis in young Canadians. For instance, only a third of the sample had a sleep duration that was outside of the recommended range. Nonetheless, it is still valuable to consider the movement behaviours in isolation in addition to their combinations as that provides insights into what specific movement behaviours are the most problematic. In the present study, the screen-time results were particularly concerning as only 8% of the participants met the screen-time recommendation. Thus, interventions that can successfully reduce screen time may be particularly helpful at improving the movement behaviour profile of young Canadians.

Strengths and limitations

A key limitation of this study is the self-reported nature of the behavioural data. This could have led to misclassification and over- or underestimated amounts of adherence to the movement behaviour guidelines and its different recommendations. It is also important to note that the assessment of MVPA was limited to activities performed in class time at school, free time outside of school, and active travel to school. Active travel to non-school destinations and activities performed during the school day outside of class time such as recess would not have been captured. Furthermore, the assessment of screen time included homework (as part of the computer use item), even though the ≤2 hour/day screen-time recommendation in the 24-Hour Movement Guidelines is specific to recreational screen time.[14] The nature of data collection also led to a lot of missing data, as many of the participants chose not to respond to all questionnaire items and/or did not have time to complete all questions. Participants with missing data were excluded from the analyses, and this would have biased the results if the movement behaviours were different in the included and excluded participants. Another limitation was that the sampling strategy excluded youth enrolled in special needs educational programs, those living on reserves, and those not attending publicly funded schools (e.g. homeless youth). Although these groups represent < 7% of Canadians in the target age range, they are amongst Canada's most vulnerable and their movement behaviours may be different than what was reported here. Additional research is needed in these vulnerable population groups.

Conclusion

While 79% of Canadians aged 10 to 17 years met one or more of the three key recommendations that are part of the new Canadian 24-Hour Movement Guidelines, less than 3% met all three recommendations. Adherence was particularly low for the screen-time and MVPA recommendations. It is hoped that the information from this descriptive study can be used to inform the development of programs and policies to promote healthy movement behaviours in school-aged children and youth.

Acknowledgements

The *2014 Canadian Health Behaviour in School-Aged Children* study and this paper were funded by the Public Health Agency of Canada. IJ was supported by a Canada Research Chair award.

Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions and statement

All authors contributed to the study concept and approved the final version. IJ conducted the statistical analyses and wrote the first draft of the manuscript. KR and WT assisted in the interpretation of results and critically revised the manuscript.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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https://doi.org/10.24095/hpcdp.37.11.02

Binge drinking and academic performance, engagement, aspirations, and expectations: a longitudinal analysis among secondary school students in the COMPASS study

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Abstract

Introduction: The longitudinal relationship between binge drinking and academic engagement, performance, and future aspirations and expectations was examined among a cohort of secondary school students.

Methods: In separate multinomial generalized estimating equations models, linked data from Year 1 (Y_1: 2012-2013), Year 2 (Y_2: 2013-2014), and Year 3 (Y_3: 2014-2015) of the COMPASS study (N = 27 112) were used to test the relative likelihood of responses to seven academic indices when binge drinking was initiated in varying frequencies, adjusting for gender, grade, race/ethnicity, tobacco use, and the individual mean of the predictor and all time-varying covariates.

Results: Among students who had never engaged in binge drinking at baseline, those who reported regular binge drinking at follow-up were relatively less likely to complete their homework, attend class, and value and achieve high grades, with more frequent binge drinking at follow-up generally resulting in larger relative risk ratios. Interestingly, shifting from "never" to "rare/sporadic" binge drinking one to two years later resulted in an increased relative risk of wanting to pursue all levels of postsecondary education. Beginning binge drinking on a "monthly" basis also increased the likelihood of college/trade or bachelor degree ambitions, relative to high school, but not graduate/professional pathways; while degree aspirations were not associated with initiating weekly binge drinking.

Conclusions: Results suggest students who initiate binge drinking have poor school performance and engagement, which may interfere with achieving their future academic goals. This study reinforces the reasons substance use prevention should be considered an academic priority, as such efforts may also prove beneficial for educational achievement.

Keywords: *binge drinking, alcohol, education, academic achievement, adolescents, school*

Highlights

- Linked longitudinal data were used to test the relative likelihood of responses to seven academic indices when binge drinking was initiated in varying frequencies among a large cohort of secondary school students.
- Students who initiated regular binge drinking at follow-up were relatively less likely to complete their homework, to attend class, and to value and achieve high grades.
- Results indicate that adolescents who initiate binge drinking have a relatively higher risk of poor academic performance, and a lack of preparedness and engagement, while their future academic aspirations and expectations remain largely intact.
- Substance use prevention efforts may also prove beneficial for academic achievement and engagement.

Introduction

Adolescent substance use prevention is a key public health priority. Alcohol is the most frequently abused substance and is associated with the leading causes of death and serious injury (including motor vehicle accidents and suicide) among youth.[1,2] Among adolescents who use alcohol, the proportion who drink heavily appears higher than among adult drinkers, and tends to occur in a more episodic manner, with binge drinking—the consumption of large volumes of alcohol (i.e. five or more standard drinks) on a single occasion—acknowledged as the dominant pattern at this age.[2,3,5] Based on 2011–2012 estimates, one-third of Canadians in Grades 10 to 12 had engaged in binge drinking within the past year.[6] Similarly, in 2012–2013, about one-quarter of Ontario secondary school students reported binge drinking in the prior year, reaching up to 36.7% of students in grade 12.[5,7]

Binge drinking typically emerges around 13 to 15 years of age, peaking in the late teenage years or early 20s, followed by a slow decline.[4,8] Underage drinking is often deemed a common transitory behaviour, reflective of the increased propensity for risk-taking during this phase; however, experts argue that adolescents are particularly vulnerable to experiencing adverse consequences from alcohol use, and binge

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consumption magnifies the risk.[1,3,9,10] The initiation of alcohol use occurs alongside changes in life roles and neurobiological maturation[11] and, therefore, has the potential to disrupt processes critical to the successful transition from childhood to adulthood. Educational achievement is an important determinant of how well this developmental stage is navigated. School failure, noncompletion, and truancy increase the likelihood of numerous problems later in life, including health-risk behaviours, criminality, violence, unemployment, and poverty.[12]

Alcohol use during adolescence may foster academic underachievement and disengagement, based on several cross-sectional studies[13,14] and selected longitudinal analyses.[15,16] For instance, heavy drinking among youth has been linked to lower school grades,[13-16] truancy,[13,17-19] and degree noncompletion.[20] However, many conflicting results also exist in the literature.[21,22] Moreover, reasons for the proposed link between substance use and education achievement remain poorly understood.

Direct causal theories point to the neurotoxicity of alcohol. Scholars widely agree that adolescence represents a period of heightened vulnerability, as the brain continues to undergo substantial development until at least the mid-20s.[3] Imaging research reveals reduced brain matter volume and integrity, as well as neurocognitive deficits (e.g. impaired memory and decision making), among heavy drinking adolescents compared to their non-/low drinking peers.[10,23,24] Frequent binge behaviour appears especially harmful, based on associations between the quantity and frequency of alcohol consumption with the persistence and degree of structural and functional abnormalities.[3,9-11] As the majority of studies have been cross-sectional in design, questions persist regarding whether reported neurocognitive differences predate (i.e. as genetic liabilities for substance use or pre-existing cognitive deficits) or result from alcohol use.[10,11]

Similarly, the direction of influence between substance use and academic achievement is uncertain. Problematic alcohol use is largely assumed to predict lower educational performance and degree attainment. In support, Latvala et al.[16] found both alcohol use and drinking to intoxication in adolescence predicted later school completion, and not vice-versa. In contrast, some evidence suggests reverse causation[14,15,17] or mutually reinforcing effects.[25,26] For example, Wang and Fredricks[26] found a bidirectional relationship between school engagement and youth substance use over time, and both factors predicted the likelihood of dropping out of school, although the independent effect of alcohol was not reported. Indirect or noncausal pathways have also been proposed.[21,27] Shared underlying risk factors such as mental health problems, low socio-economic status (SES), family instability, and a lack of parental monitoring and support may predispose adolescents to both underachievement and substance use. A similar theory contends drug use is simply one aspect of an overall pattern of problem behaviours.

Interpretation of the existing literature is also hindered by inconsistent measures of academic achievement or the reliance on degree completion as the only outcome measure. School dropout is likely preceded by a period of student apathy, declining grades, truancy, and/or disciplinary problems. Incorporating a range of academic outcomes would help to elucidate the potential mechanisms through which binge drinking may lead to school dropout. Also, focusing solely on degree attainment overlooks any adverse influences of binge drinking on school performance and engagement among students who manage to graduate. Past research on alcohol use may fail to adequately capture the impact on academic outcomes experienced by adolescents who binge drink, the dominant pattern of alcohol use at this age. To help clarify the above discussed ambiguities, the current study tested multiple models among a large cohort of secondary school students with the initiation of binge drinking in varying frequencies predicting several indices of educational engagement, performance, aspirations, and expectations.

Methods

Design

The COMPASS study is a prospective cohort study designed to collect hierarchical longitudinal data from a sample of Grade 9 to 12 secondary school students and the schools they attend in Ontario and Alberta, Canada.[28] The current study reports longitudinal student-level linked data from Year 1(Y_1: 2012–2013), Year 2(Y_2: 2013–2014), and Year 3(Y_3: 2014–2015). A full description of the COMPASS study methods is available in print[27] or online (www.compass.uwaterloo.ca). The University of Waterloo Office of Research Ethics (ORE #17264) and appropriate school board committees approved all procedures.

Participants

In Y_1, 43 schools were purposefully recruited because they permitted use of active-information passive-consent parental permission protocols,[28] which is critical for collecting robust data on youth substance use.[29] Students could decline to participate at any time. In Y_1, data were collected from 24 173 Grade 9-12 students (80.2% participation rate) in 43 schools. Y_2 data were collected from 23 424 Grade 9-12 students (78.2% participation rate) in the same 43 schools, and an additional 46 schools were recruited into the study where data were collected from 21 874 Grade 9-12 students (80.2% participation rate). Y_3 data were collected from 42 355 Grade 9-12 students (78.7% participation rate) in 87 schools (two schools of the 43 Y_1 schools dropped out between Y_2 and Y_3). Missing respondents resulted primarily from scheduled spares/free periods or absenteeism during data collection.

To explore longitudinal changes, we linked Y_1, Y_2, and Y_3 student-level data within schools. The process of linking the student data across waves is described in more detail by Qian and colleagues.[30] Due to the rolling sample design,[28] it was not possible to link the Grade 12 students in Y_1 or the Grade 12 students in Y_2 that graduated, or the Grade 9 students that were newly admitted to schools in Y_3. The other main reasons for non-linkage included students transferring schools, absent or on spares, dropping out of school, or inaccurate or missing data provided in the linkage measures. Overall, 27 329 students were successfully linked for at least two years of the study (linkage rates for Y_1, Y_2, and Y_3 were 51.4%, 57%, and 50%, respectively), with 18.0% (n = 4914) completing the questionnaire in all three years. Only students that were linked for two or three waves of data were included in the analyses. Missing data were treated as missing at random and excluded on an analysis-by-analysis basis. Based on previous analyses,[30] students with better academic performance were less likely to be missing; however, results of a preliminary longitudinal regression analysis (generalized estimating equations [GEE] model)

supported our assumption that the transition/change in the academic outcomes over study waves were similar for missing and nonmissing groups, with the exception of the homework completion variable. Homework completion may be subject to nonresponse bias and should be interpreted with caution.

Data collection tool

The student-level questionnaire for COMPASS (Cq) collects individual student data pertaining to multiple behavioural domains (substance use, physical activity, diet, etc.), correlates, and demographic characteristics. In each school, the Cq was used to collect whole-school samples during class time. The Cq items were based on national standards or current national public health guidelines as described elsewhere.[28] The cover page of the Cq contains measures required to create a unique self-generated code for each respondent in a school to ensure the anonymity of the survey participants, while still allowing COMPASS researchers to link each student's unique identifier data over multiple years.

Measures

Binge drinking

To assess *binge drinking*, students were asked "In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?". Responses were recoded as "never" if students reported they had never drunk alcohol, had only had a sip of alcohol, had never had 5 or more drinks on one occasion, or had not done so within the past 12 months. Participants were considered to binge drink on a "rare/sporadic" basis if they responded "less than once a month", on a "monthly" basis if they responded "once a month" or "two to three times a month", and "weekly" if they engaged in binge drinking "once a week" or "two to five times a week." Students who responded "daily or almost daily" binge drinking over the last 12 months were deemed probable misreports and excluded. While the available Cq measure does not align with the low-risk drinking guideline for binge drinking among females,[31] it is consistent with previous research[5,7,28] and national surveillance tools.[32]

Academic variables

Academic aspirations and *expectations* were assessed by asking, "What is the highest level of education you would *like* to get?" and "What is the highest level of education you *think* you will get?" respectively.

To measure *academic performance*, students were asked "In your current or most recent Math course, what is your approximate overall mark?" The same question was used to assess English marks.

The following survey items were intended to reflect different aspects of *school engagement*. The value students assigned to school performance was assessed by how strongly they agreed with the statement, "Getting good grades is important to me". Truancy was determined by the number of classes skipped when not supposed to in the last four weeks. Lastly, participants were asked, "how often do you go to class without your homework complete?"

Spearman rank correlation coefficients were calculated to examine correlations between the academic variables. Overall, the coefficients indicated significant weak correlations in the expected direction between the various indices (see Table 1). Response categories for all academic variables are shown in Table 2. Some categories were collapsed if the number of responses was insufficient to be modelled.

Covariates

All regression models were adjusted for student-reported gender (male, female), grade (9-12), and race/ethnicity (White, Black, Asian, Hispanic, off-reserve Aboriginal, other/mixed/missing), given evidence of variations in drinking behaviour and in educational engagement, performance, and/or degree attainment among these sociodemographic groups.[5,33-35] Models also adjusted for tobacco cigarette use (current, past, never), as it tends to cluster with many suggested confounders (e.g. parental education and substance use, as well as low SES). Age was not included due to the high correlation with grade, which is a more meaningful indicator for school-based prevention planning.

Statistical analysis

Descriptive statistics were calculated using statistical package SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) for responses at first participation in the COMPASS study (baseline).

Multinomial GEE models were used to explain the within-individual associations of each of the academic variables with binge drinking. Models require specification of marginal regression models and correlations. Suppose there are J response categories and the J^{th} category is the baseline. We modeled the marginal regression model as a baseline category logit model, such that,

$$\log\Pr Y_{it} = j \mid x_{it}) / \Pr(Y_{it} = J \mid x_{it}) = \beta_{0j} + \beta_{1j}^{T} x_{it} \quad \text{for } j = 1, 2, \text{ and } J - 1,$$

where Y_{it} is the t^{th} observation for student i, x_{it} is the vector of covariates or predictors, and β_{0j} and β_{1j} are the j^{th} category

TABLE 1
Spearman rank correlation coefficients between the academic variables in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	1	2	3	4	5	6
1. Level of education would *like* to get						
2. Level of education *expect* to get	0.72*					
3. How often goes to class *without* homework complete	0.09*	−0.11*				
4. Number of classes skipped in last 4 weeks	−0.12*	−0.14*	0.23*			
5. "Getting good grades is important to me"	−0.20*	−0.23*	0.29*	0.20*		
6. English course mark	−0.21*	−0.24*	0.20*	0.13*	0.34*	
7. Math course mark	−0.18*	−0.21*	0.20*	0.13*	0.30*	0.44*

Notes: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.

For the level of education students would *like* to or *expect* to get, higher numbers indicate higher degrees (i.e. in the order of: high school, college/trade/vocational, bachelor's, graduate/professional). For other variables, higher numbers indicate lower English or Math marks, or that students report skipping classes or not completing their homework more often. Student responses are pooled for all available data for the three years of available data, as each year closely resembled the other years when calculated separately.

*$p < .0001$.

TABLE 2
Baseline frequency statistics of binge drinking, academic, and covariate measures in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	Females n = 14 323 n (%)[a]	Males n = 12 789 n (%)[a]	Chi-square
Grade			
9	6301 (44.0)	5747 (44.9)	
10	4494 (31.4)	3862 (30.2)	$p < .0001$
11	3319 (23.2)	2839 (22.2)	
12	209[b] (1.5)	341 (2.7)	
Race/ethnicity			
White	11 060 (77.2)	9646 (75.4)	
Black	409 (2.9)	554 (4.3)	
Asian	761 (5.3)	677 (5.3)	$p < .0001$
Off-reserve Aboriginal	374 (2.6)	334 (2.6)	
Hispanic	257 (1.8)	274 (2.1)	
Other/mixed/missing	1462 (10.2)	1304 (10.2)	
Tobacco use (cigarettes only)			
Current	273 (1.9)	355 (2.8)	$p < .0001$
Past	64 (0.5)	56 (0.4)	
Never	13 986 (97.6)	12 378 (96.8)	
Binge drinking frequency			
Never	8879 (62.0)	8242 (64.5)	
Rare/sporadic	3378 (23.6)	2634 (20.6)	$p < .0001$
Monthly	1691 (11.8)	1502 (11.7)	
Weekly	375 (2.6)	411 (3.2)	
Level of education would *like* to get			
High school equivalency or less	451 (4.0)	596 (5.9)	
College diploma/trade/vocational	1929 (17.0)	3078 (30.3)	$p < .0001$
University bachelor's degree	2386 (21.0)	2267 (22.3)	
Master's/PhD/law/medical/teacher's college	6582 (58.0)	4223 (41.6)	
Level of education *expect* to get			
High school equivalency or less	688 (6.3)	702 (6.9)	
College diploma/trade/vocational	2563 (23.6)	3576 (35.3)	$p < .0001$
University bachelor's degree	3059 (28.2)	2764 (27.3)	
Master's/PhD/law/medical/teacher's college	4557 (41.9)	3093 (30.5)	

Continued on the following page

specific parameter vectors. Person-mean centering is used for time-varying predictors to disaggregate between-person and within-person effects for the time-varying predictor.[36] As binge-drinking status has multiple categories, we first transformed the categorical predictor into multiple dummy variables and then calculated their personal means across time. Those dummy variables and their personal means are included in the model.[37] This technique was also applied to other time-varying covariates.

To evaluate the impact of within-school association, Kendall's tau coefficients were calculated for all pairs of observations from different students within the same school for all academic variables. The values ranged from -0.013 to -0.001, which suggested weak within-school association. In contrast, Kendall's tau coefficients for all pairs of observations from the same student (range 0.32, 0.60) indicated strong within-individual association. In the model, the within-individual association at the student level were constructed using local odds ratios.

The computation was implemented using the R package *multgee*.[38] More details can be found in Touloumis et al.[39,40] Separate models were constructed for the effect of binge drinking on each academic outcome variable. The total sample (i.e. students linked for at least two waves of data) was included in all models. To simplify our tables, and to inform prevention strategies, only the relative results for students who went from "never" binge drinking at baseline to the other binge drinking groups at follow-up are presented. Models were adjusted for gender, grade, race/ethnicity, and tobacco use.

Results

Descriptive statistics

After excluding students with probable misreports (i.e. "daily or almost daily" binge drinking over the last year; n = 217), a final sample of 27 112 remained for the analyses. Table 2 presents the baseline frequency statistics in the first year that students participated. Few students had used tobacco, and the majority identified as White, and 52.8% as female. At baseline, 38.0% of females and 35.6% of males had engaged in binge drinking, with about 15% doing so once a month or more. Baseline responses to the academic variables were encouraging, with most students valuing good grades, achieving high marks, attending classes, regularly completing their homework, and aspiring to pursue postsecondary education.

The cross-sectional distribution of student responses to the binge drinking frequency measure by year of data collection is presented in Figure 1 for the total sample,

TABLE 2 (continued)
Baseline frequency statistics of binge drinking, academic, and covariate measures in the three-year linked sample of secondary school students in the COMPASS study, 2012–2015

	Females n = 14 323 n (%)*	Males n = 12 789 n (%)*	Chi-square
Math course mark			
90–100%	2907 (20.8)	2356 (19.0)	
80–89%	4479 (32.0)	3765 (30.4)	$p < .0001$
70–79%	3422 (24.4)	3176 (25.6)	
60–69%	1795 (12.8)	1764 (14.2)	
Less than 60%	1401 (10.0)	1343 (10.8)	
English course mark			
90–100%	2259 (16.2)	1053 (8.6)	
80–89%	6097 (43.6)	4201 (34.1)	$p < .0001$
70–79%	3932 (28.2)	4468 (36.3)	
60–69%	1208 (8.7)	1765 (14.3)	
Less than 60%	469 (3.4)	822 (6.7)	
"Getting good grades is important to me"			
Disagree/strongly disagree	41? (2.9)	719 (5.8)	$p < .0001$
Agree	4790 (33.9)	5436 (43.6)	
Strongly agree	8924 (63.2)	6304 (50.6)	
How often goes to class *without* homework complete			
Never	3454 (24.5)	2448 (19.6)	
Seldom	7807 (55.4)	6782 (54.3)	$p < .0001$
Often	1959 (13.9)	2245 (18.0)	
Usually	869 (6.2)	1016 (8.1)	
Number of classes skipped in last 4 weeks			
0	11 376 (80.5)	10 392 (83.1)	$p < .0001$
1–5	2535 (18.0)	1891 (15.1)	
6+	204 (1.5)	223 (1.8)	

Notes: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.
Student responses are reported for the first year a respondent participated.

* Numbers may not add to total because of missing values.

and in Figure 2 for students with all three years of linked data available. The transition of students between binge drinking categories from Y_1 to Y_2 and from Y_2 to Y_3 is presented in Table 3.

Multinomial GEE models

Table 4 presents the relative risk ratios (RRRs) of students reporting college, university, or graduate/professional academic aspirations and expectations over "high school equivalency or less", when student reports shifted from "never" binge drinking at baseline to "rare/sporadic", "monthly", or "weekly" in the one to two years following. Reported results are adjusted for student-identified gender, race/ethnicity, and grade. Students who began binge drinking on a rare/sporadic basis at follow-up were more likely to report *aspirations* to pursue all levels of higher education rather than aim to discontinue their education at high school, but were no more or less likely to report different degree *expectations*. Starting to binge drink monthly in the following year or two increased the odds of college/trade school and university bachelor ambitions and expectations after high school, but did not impact the likelihood of reporting graduate/professional degree goals or expectations. The initiation of binge drinking on a weekly basis at follow-up did not influence the relative likelihood of the degree students aspired or expected to achieve.

Table 4 also presents the academic engagement and performance models, adjusted for the covariates. Students who went from never binge drinking at baseline to regular binge drinking at follow-up were more likely to attend class with incomplete homework, skip class, achieve high marks, and disagree that good grades were important to them, than to complete their homework, attend class, report marks less than 60%, and strongly agree that good grades were important to them. Students who initiated rare/sporadic binge drinking were also relatively less likely to complete their homework, achieve high English marks, and agree that good grades were important, in comparison to the reference category response options.

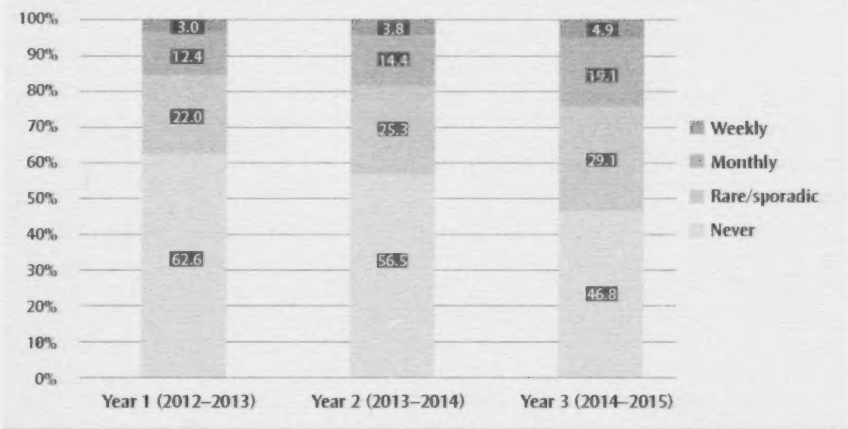
Overall, based on the RRRs, the more frequent the initiated binge drinking, the lower the likelihood of high academic performance and engagement.

Discussion

Previous research has been inconsistent on the link between alcohol use and academic achievement. To ascertain whether the findings were similar among high-risk drinkers—the population typically targeted by prevention strategies—the current study examined how the initiation of binge drinking during adolescence impacts educational performance, engagement, and future goals and expectations. Among a large cohort of secondary school students in the COMPASS study, linked longitudinal data was used to test the relative likelihood of different responses to various academic indices when participants went from never binge drinking at baseline to reporting varying frequencies of binge drinking one or two years later.

As expected, students who started regular binge drinking were more likely to report academic disengagement and poor performance than to regularly attend class, complete their homework, consider good grades important, and achieve high marks. Results lend support to a step-wise relationship; that is, the more frequent the binge drinking reported at follow-up, the lower the likelihood of being engaged and performing well in school. On the other hand, when asked about their academic

FIGURE 1
Binge drinking frequency in the total three-year linked sample of secondary school students in the COMPASS study

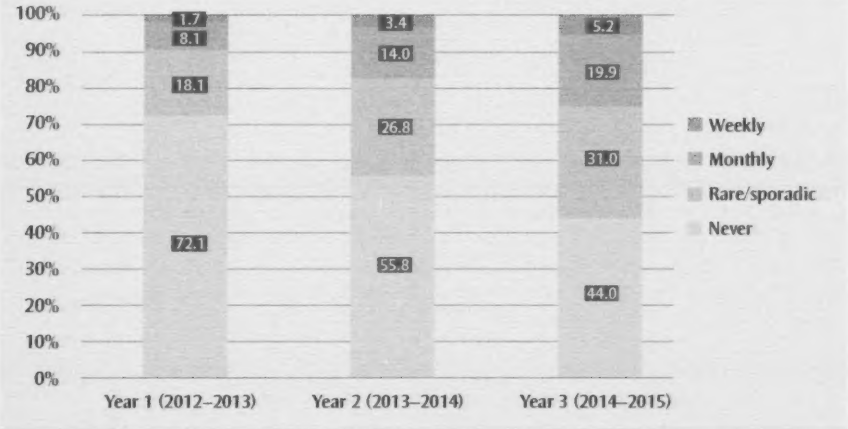


Note: Sample size is 12 317 in year 1, 25 675 in year 2 and 21 088 in year 3.

goals, youth who began binge drinking on a rare/sporadic or monthly basis had a greater relative risk of reporting ambitions and expectations to pursue higher education past high school. Students who commenced weekly binge drinking were no more or less likely to indicate postsecondary degree ambitions. Similarly, the degree-level students expected to achieve did not appear to change when binge drinking was initiated at a rare/sporadic or weekly frequency.

The multiple academic indices and range of binge drinking frequencies included in this study, and the varying findings among the models, shed light on potential sources of disagreement in past research, which was often limited to dichotomous alcohol use variables or single academic outcome measures. The majority of the various academic indices included in the current study had weak correlations. Wormington and colleagues[41] argue literature inconsistencies resulted from aggregation of qualitatively different types of educational motives. Past conflicting results tend to centre around degree attainment,[21,22] whereas findings with school engagement have been more consistent, although many of these studies only included truancy to indicate disengagement.[13,17,18] In the current study, while students who started binge drinking had the anticipated greater risk of disengagement and poor performance, which increased with the initiation of more frequent binge drinking, results of the academic expectations and aspirations models were null or in the opposing direction. In other words, although engagement and performance suffered, the future ambitions to pursue higher education appeared to remain largely intact when students commenced binge drinking. Consistent with this finding, the academic expectation and aspiration variables had relatively weaker correlations with the indicators of academic engagement and performance. Whether the disengagement and poor performance prevents students from achieving their educational goals may depend on whether binge drinking is sustained,[42] supporting the need for early intervention efforts targeting heavy alcohol users.

FIGURE 2
Binge drinking frequency by study wave among secondary school students with three years of linked data from the COMPASS study



Note: Sample size is 4856.

Compared to other substances of abuse, the literature demonstrates less robust or consistent links between alcohol and education.[21,22,27] Some experts theorize alcohol is more compatible with academic achievements than other drug use.[22] Drinking is legal and socially accepted, or even encouraged, in certain circles. The models of students' academic aspirations to pursue postsecondary school are interesting, as alcohol is often affiliated with the culture of higher education. Some evidence suggests the perception of more permissive drinking cultures contributes to heavier alcohol intakes, and postsecondary students are shown to overestimate their classmates' alcohol consumption[43] and to have higher drinking frequencies than their peers not attending school.[44] In light of these findings, interventions have been developed to alter campus culture and correct misperceptions of student drinking norms.[45] Similar programs may be valuable earlier, as it is plausible that perceptions of postsecondary cultures contribute to drinking among adolescents planning to pursue scholarly paths.

Alternatively, drawing from the drinking motives literature, students may binge drink to cope with the pressure to succeed academically. It is plausible that distress related to school pressures, particularly higher-educational aspirations, may drive binge drinking via coping motives, which in turn, adversely

TABLE 3
Transition of secondary school students' binge drinking frequency from year 1 to year 2 and from year 2 to year 3 of the COMPASS study

	Year 2				
	Never	Rare/sporadic	Monthly	Weekly	Total
Year 1	n (%)	n (%)	n (%)	n (%)	
Never	4629 (68.2)	1559 (23.4)	469 (6.7)	84 (1.6)	6741
Rare/sporadic	373 (14.1)	1246 (51.1)	720 (29.6)	112 (5.1)	2451
Monthly	87 (5.1)	346 (25.3)	722 (53.3)	209 (16.3)	1364
Weekly	13 (3.5)	38 (11.9)	110 (33.9)	163 (50.7)	324
Total	**5102**	**3189**	**2021**	**568**	**10 880**
	Year 3				
	Never	Rare/sporadic	Monthly	Weekly	Total
Year 2	n (%)	n (%)	n (%)	n (%)	
Never	8382 (69.2)	2755 (22.7)	845 (7.0)	139 (1.2)	12 121
Rare/sporadic	733 (15.6)	2311 (50.2)	1378 (30.0)	179 (3.9)	4601
Monthly	166 (7.1)	560 (23.9)	1242 (53.0)	380 (16.2)	2348
Weekly	42 (7.2)	66 (11.4)	224 (38.6)	249 (42.9)	581
Total	**9323**	**5692**	**3689**	**947**	**19 651**

Note: Year 1: 2012–2013, year 2: 2013–2014 and year 3: 2014–2015.

impacts school performance and engagement. Some evidence suggests increased drinking predicts declining socio-emotional functioning, which has negative implications on academic performance.[15] In addition to a mediator role, poor mental health or emotional dysregulation likely represents a common risk factor, placing students at greater risk of both problematic alcohol use and academic underachievement.[34] Some studies indicate the effects of substance use on educational variables are attenuated or no longer significant after adjustment for mental health;[19] however, King *et al.*[46] found support for substance use as both a mediator and a marker of a broader spectrum of problems which reduce academic achievement.

Future research should confirm the current study results with control for student mental health, as well as other potential confounders, such as parental substance use, education, and income. Adolescents from low-SES households may have greater risk of exposure to substance abuse by family members, and lack role models with higher degrees. Moreover, parents with lower education or incomes potentially provide less support for school work and scholarly pursuits due to longer and less flexible work hours, lower perceived competence, or insufficient financial resources to support scholarly goals. Interestingly, Roebroek and Koning[25] found a bidirectional relationship between alcohol consumption and school engagement, but only among adolescents with lower levels of parental support. Tobacco use was adjusted for in the models as it tends to cluster with many proposed confounders. Indeed, classification as a current smoker had the largest adverse effect on the academic outcomes in all models, relative to binge drinking status and the other covariates (results not shown). Students who identified as female, in higher grades, and/or as Aboriginal or Black were also more vulnerable to academic disengagement, poorer performance, and a lack of postsecondary degree aspirations and expectations, relative to their counterparts who reported they were male, in lower grades, and/or White, respectively (results not shown).

Considering the prevalence of binge drinking among youth[5-7] and importance of educational achievement to their future opportunities,[12] increased prevention efforts are of critical importance. Schools have been identified as the ideal setting for such strategies given the ability to reach the large majority of the population, regardless of SES. Targeted efforts at marginalized groups more vulnerable to academic underachievement may be warranted. Based on the current study, school-based prevention programs may ultimately benefit not only students' well-being, but their academic engagement and performance. Some evidence indicates enhancing recognition of the hazards of alcohol use may assist in reducing adolescent binge drinking, and in turn, improve educational attainment.[47] For example, young teenagers with high risk perceptions of substance use were less likely to binge drink as high school seniors, which was associated with greater chances of graduating from high school and attending college.[48]

Strengths and limitations

Primary strengths of the study include the large sample and linked data, as well as the multiple academic indices and range of binge drinking frequencies; Nonetheless, certain limitations should be taken into account when interpreting results. While the longitudinal design and statistical procedures strengthen inferences, bidirectional effects were not tested. Secondly, no data was available on certain suggested confounders (e.g. mental health, SES, family support, parental substance use). Also, although self-report methods are considered reliable and valid approaches to measuring alcohol consumption,[49] recall bias and underreporting remain possible, and linkage rates are lower for students who use substances and are less engaged in school.[50] Missing data were treated as missing at random and excluded based on analyses indicating the transition in academic outcomes was similar in missing and nonmissing samples, with the exception of the homework completion outcome, which may be subject to nonresponse bias, and should be interpreted with caution. To encourage honest reporting, and improve participation and representativeness, passive-consent procedures were used, and students were not asked to provide their names, were assured confidentiality, and were not made aware of the data collection date ahead of time.[50] Lastly, to be consistent with previous research[5,7] and tools,[32] binge drinking was defined as consuming five or more alcoholic beverages on one occasion and assessed with reference to the past 12 months; however, measures using shorter timeframes can be more reliable,[49] and lower cut-off points have been suggested for females and/or youth.[2]

TABLE 4
Multinomial GEE models of secondary school student binge drinking with academic performance, engagement, and aspirations in years 1 to 3 of the COMPASS study

	Binge drinking frequency (vs. Never)		
	Rare/sporadic	Monthly	Weekly
	RRR[a] (95% CI)	RRR[a] (95% CI)	RRR[a] (95% CI)
Level of education would like to get (vs. High school equivalency or less) (n = 20 458)[b]			
College/trade/vocational	1.38 (1.13–1.68), $p = .0014$	1.39 (1.08–1.78), $p = .0095$	1.35 (0.93–1.97), $p = .1128$
Bachelor's	1.43 (1.18–1.72), $p = .0002$	1.39 (1.09–1.77), $p = .0089$	1.46 (1.00–2.12), $p = .0514$
Graduate/professional	1.27 (1.06–1.52), $p = .0098$	1.25 (0.99–1.59), $p = .0598$	1.08 (0.75–1.55), $p = .6832$
Level of education expect to get (vs. High school equivalency or less) (n = 19 869)			
College/trade/vocational	1.16 (0.98–1.37), $p = .0753$	1.32 (1.06–1.63), $p = .0116$	1.28 (0.92–1.79), $p = .1475$
Bachelor's	1.14 (0.98–1.34), $p = .0950$	1.28 (1.04–1.57), $p = .0213$	1.16 (0.83–1.62), $p = .3803$
Graduate/professional	1.08 (0.93–1.26), $p = .3115$	1.16 (0.95–1.42), $p = .1408$	1.05 (0.76–1.47), $p = .7536$
How often do you go to class without your homework complete? (vs. Never) (n = 26 310)			
Seldom	1.38 (1.21–1.58), $p < .0001$	1.90 (1.58–2.28), $p < .0001$	2.33 (1.75–3.11), $p < .0001$
Often	1.40 (1.27–1.54), $p < .0001$	1.59 (1.39–1.83), $p < .0001$	1.87 (1.48–2.37), $p < .0001$
Usually	1.19 (1.10–1.29), $p < .0001$	1.19 (1.06–1.34), $p = .0040$	1.12 (0.90–1.39), $p = .3041$
Number of classes skipped (when not supposed to) in the last 4 weeks (vs. 0) (n = 26 360)			
1–5	1.43 (1.32–1.55), $p < .0001$	1.80 (1.62–1.99), $p < .0001$	2.17 (1.85–2.54), $p < .0001$
6+	1.59 (1.23–2.06), $p = .0004$	2.66 (2.00–3.55), $p < .0001$	4.77 (3.35–6.80), $p < .0001$
"Getting good grades is important to me" (vs. Strongly agree) (n = 26 239)			
Agree	1.21 (1.05–1.39), $p = .0078$	1.41 (1.17–1.69), $p = .0003$	1.78 (1.38–2.30), $p < .0001$
Disagree/strongly disagree	1.05 (0.99–1.11), $p = .0846$	1.20 (1.11–1.30), $p < .0001$	1.39 (1.21–1.59), $p < .0001$
Mark in most recent English course (vs. Less than 60%) (n = 26 021)			
60–69%	0.95 (0.83–1.09), $p = .4795$	0.93 (0.78–1.11), $p = .4286$	0.72 (0.55–0.95), $p = .0206$
70–79%	0.85 (0.76–0.95), $p = .0060$	0.77 (0.67–0.90), $p = .0006$	0.62 (0.49–0.78), $p < .0001$
80–89%	0.86 (0.77–0.96), $p = .0079$	0.85 (0.74–0.97), $p = .0195$	0.74 (0.60–0.92), $p = .0062$
90–100%	0.87 (0.78–0.98), $p = .0164$	0.82 (0.71–0.95), $p = .0089$	0.71 (0.56–0.90), $p = .0051$
Mark in most recent Math course (vs. Less than 60%) (n = 26 132)			
60–69%	0.87 (0.72–1.05), $p = .1433$	0.83 (0.65–1.06), $p = .1335$	0.65 (0.47–0.92), $p = .0135$
70–79%	0.91 (0.77–1.07), $p = .2341$	0.79 (0.64–0.97), $p = .0224$	0.51 (0.38–0.69), $p < .0001$
80–89%	0.86 (0.74–1.01), $p = .0588$	0.75 (0.61–0.91), $p = .0041$	0.53 (0.39–0.70), $p < .0001$
90–100%	0.85 (0.72–1.00), $p = .0549$	0.70 (0.56–0.87), $p = .0014$	0.47 (0.33–0.68), $p < .0001$

Abbreviations: CI, confidence interval; GEE, generalized estimating equations; RRR, relative risk ratio.

Notes: Year 1: 2012-2013, year 2: 2013-2014 and year 3: 2014-2015.

Results reflect the likelihood of students reporting the indicated response category relative to reference category when they shift from reporting "Never" binge drinking at baseline to "Rare/Sporadic", "Monthly", or "Weekly" at follow-up.

[a] Adjusted for gender, grade, race/ethnicity, tobacco use, and the individual mean of all time-varying covariates and the predictor.

[b] The varied sample size by model reflects the treatment of missing data as missing completely at random, and exclusion on analysis-by-analysis basis.

Conclusion

Results showcase the need to increase and improve prevention strategies for problematic drinking among youth, a cohort believed to have heightened vulnerability to the negative effects of substance use. These efforts should be considered a priority in educational systems, given the potential to improve student engagement and performance, and avoid the many lifelong consequences associated with school failure and dropout.[12] Based on this study, the initiation and escalating frequency of binge drinking appears detrimental to student attendance, homework completion, grades, and perceived value of school achievement, which may impede students from reaching their future academic goals.

Acknowledgements

The COMPASS study was supported by a bridge grant from the Canadian Institutes of Health Research (CIHR) Institute of Nutrition, Metabolism and Diabetes (INMD) through the "Obesity – Interventions to Prevent or Treat" priority funding awards (OOP-110788; grant awarded to S. Leatherdale) and an operating grant from the CIHR

Institute of Population and Public Health (IPPH) (MOP-114875; grant awarded to S. Leatherdale). Dr. Leatherdale is a Chair in Applied Public Health Research funded by the Public Health Agency of Canada (PHAC) in partnership with CIHR.

Conflicts of interest

The authors have no conflicts of interest to report.

Authors' contributions and statement

KP led the writing of the manuscript and the study concept. WQ carried out the data analysis. All authors informed the data analysis and design, contributed to interpretation of the results, and approved the final version.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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https://doi.org/10.24095/hpcdp.37.11.03

Between worst and best: developing criteria to identify promising practices in health promotion and disease prevention for the Canadian Best Practices Portal

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Abstract

Introduction: In health promotion and chronic disease prevention, both best and promising practices can provide critical insights into what works for enhancing the health-related outcomes of individuals and communities, and how/why these practices work in different situations and contexts.

Methods: The promising practices criteria were developed using the Public Health Agency of Canada's (PHAC's) existing best practices criteria as the foundation. They were modified and pilot tested (three rounds) using published interventions. Theoretical and methodological issues and challenges were resolved via consultation and in-depth discussions with a working group.

Results: The team established a set of promising practices criteria, which differentiated from the best practices criteria via six specific measures.

Conclusion: While a number of complex challenges emerged in the development of these criteria, they were thoroughly discussed, debated and resolved. The Canadian Best Practices Portal's screening criteria allow one to screen for both best and promising practices in the fields of public health, health promotion, chronic disease prevention, and potentially beyond.

Keywords: best practices, promising practices, screening criteria, intervention studies, evaluation, public health, health promotion, chronic disease prevention

Highlights

The criteria for Promising Practices were developed using an iterative review process. Promising practices differ from best practices according to the following six measures:

1. The program can be reported in grey literature reports as opposed to only peer-reviewed articles.
2. The positive program outcomes can be short-term only (within 6 months of the intervention period) or only during the intervention period.
3. The program can be low impact in that the positive outcomes affect less than half of the people they were meant to affect, or the positive outcomes are significant at a minimal acceptable level.
4. The program can be implemented in the field only once and this can be a pilot test implementation.
5. The program may require the participation of personnel with specialized skills that are rarely accessible within the intervention context.
6. The quality of the study used to evaluate the program may be of only moderate quality.

Introduction

In 2004, the Public Health Agency of Canada (PHAC) identified a critical need, as expressed by health practitioners, to have increased access to program-specific evidence to help them make informed decisions when designing, implementing, and evaluating community-based health promotion and chronic disease prevention interventions.[1,2] To address this need, PHAC launched the Canadian Best Practices Portal for Health Promotion and Chronic Disease Prevention (the Portal).[3,4] In order to identify best practices for inclusion on the Portal, inclusion and exclusion criteria were developed.[5-8] The Portal became a public, searchable database of best practice interventions for practitioners where users could search online, based on a number of program variables including topic of interest, target group of focus, program strategy, etc. Although over the years, PHAC ensured that the Portal focused on the gold standard for best practices in chronic disease prevention and health promotion, promising practices remained an untapped resource of intervention evidence and learning. Numerous public health interventions from across Canada did not qualify as a best practice; yet, other promising initiatives were bringing forth knowledge that was very useful to public health practitioners. In 2013, PHAC recognized the important need to expand the Portal to also include promising practices; this need was identified by the CBPI Advisory Group, and acknowledged more formally in a 2013/14 branch-wide meeting report for the CBPI regarding priority setting and the 2013/14 Knowledge Development and Exchange (KDE) Plan for the Centre for Chronic Disease Prevention. The work to

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expand the Portal to include promising practices allowed PHAC to tap into these rich sources of Canadian and international evidence, while still maintaining a focus on high quality methods and established criteria.

This paper is a result of the work that was accomplished to create inclusion and exclusion criteria so that promising practice interventions could also be included on the Portal, and it highlights the methodological and practical challenges encountered when developing these criteria. We began this study with the understanding that a *promising practice* is an intervention, program/service, strategy, or policy that shows potential (or 'promise') for developing into a best practice; and, that a *best practice* is an intervention that has repeatedly demonstrated a positive impact on the desired objectives of the intervention, given the available evidence, and is deemed most suitable for a particular situation or context. To our knowledge, there are no other databases/portals or criteria that distinguish between best and promising practices.

Overall, the main objectives of this study were to: (1) develop clear screening criteria to distinguish between best and promising practices in health promotion and chronic disease prevention; (2) use published interventions to pilot test these screening criteria with the Promising Practices Working Group (the working group) to ensure the criteria work across a range of study designs; and (3) in the interest of transparency, make these screening criteria accessible and easy to understand for all users.

Methods

Phase I: Establishing criteria for promising practices

We (NF and SJ) conducted a review of the related peer-reviewed and grey literature to gain insight about the ways in which promising practices have been understood, defined, classified, and talked about by academics and practitioners in the field of health promotion and chronic disease prevention. We used two major health-related bibliographic databases (MEDLINE and EMBASE) as well as Google Scholar to search for peer-reviewed literature. Key search terms included combinations of: 'promising/emerging/best/innovative practice/intervention,' 'inclusion/exclusion/screening criteria,' 'definition/classification,' 'program(me) evaluation,' and 'health promotion/disease prevention.' We also used Google to conduct internet-based searches for grey literature, and searched for non-academic reports and documents on the websites of selected relevant health-related and research organizations, such as the Canadian Public Health Association (CPHA), the Cochrane Collaboration, the National Collaborating Centre for Methods and Tools (NCCMT), the Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre), and the National Institutes of Health (NIH).

Using the Portal's existing best-practices screening criteria as a starting point, we looked specifically for characteristics of interventions and evaluation study designs that would unequivocally distinguish a promising practice from a best practice and an excluded practice (a practice that does not qualify as either a best or promising practice). Since a promising practice is an intervention that may potentially develop into a best practice, we started with the same three pillars as those for the Portal's existing best practices: 1) the overall impact of the intervention; 2) the degree to which the intervention is adaptable and generalizable to other contexts and populations; and 3) the quality and strength of the evidence provided from the intervention evaluation, taking into consideration the strength of various study designs.

After completing this literature review, we synthesized the information into a list of potential definitions and criteria for promising practices. We then shared these criteria with the working group (see Acknowledgements section for a full list of the working group members), and made revisions based on the feedback from this group. Next, the criteria were tested using three pilot tests in a stepwise approach.

Phase II: Pilot tests - Distinguishing between promising and excluded practices

For the first pilot test, seven interventions related to the promotion of positive maternal and infant health (which were previously rejected from consideration on the Portal as best practices), were re-assessed by NF (first author) using the newly developed promising practices criteria. Based on this pilot, a simpler, all-in-one triage system was introduced by establishing criteria that screened an intervention in or out before moving forward with the more time-intensive quality of evidence review process. Additional refinements were made to the screening criteria based on the findings from this pilot test and discussions with the working group; these refinements were made because of key issues that we faced (discussed further below).

For the second pilot test, four best practices reviewers for the Portal, working in pairs, were asked to review a set of three to four interventions in pairs (including NF, KW and JY). For these reviews, eight obesity prevention interventions and five mental illness prevention interventions that did not previously qualify as best practices were reassessed. In order to establish inter-rater reliability, each pair of reviewers compared their notes for each criterion of each intervention. The reviewers noted and discussed any discrepancies between their ratings or interpretation of the criteria. Scoring agreement between and across pairs confirmed the generic qualities of the criteria. When there were disputes, the working group discussed the dilemmas and reached a consensus about revising the criteria (some of the key issues, such as defining cut-off points and defining the significance of impact, are discussed in the Discussion section). Both the first and second pilot tests assessed the screening criteria's ability to distinguish between promising and excluded practices. The next phase was to determine whether the revised criteria were effective in differentiating between best, promising, and excluded practices.

Phase III: Pilot test - Distinguishing among best, promising and excluded practices

For the third pilot test, seven experienced reviewers each assessed four to nine interventions from a pool of 62 interventions that focused on mental illness prevention, injury prevention, violence prevention, tobacco control, maternal-infant health promotion and healthy eating. The focus of this review was to test the ability of the revised criteria to assess new interventions as best, promising, or excluded. Each reviewer independently completed a feedback form, identifying any issues or challenges they encountered in applying the screening criteria. The information from these forms were compiled by NF (first author), and the key themes and issues

that emerged were discussed with the working group. Consensus was reached among all group members on all issues that emerged, and the necessary refinements were made to the criteria (some of the key issues at this stage were: capturing changes in context consistently, handling multiple papers about the intervention, and defining the significance of impact). This pilot resulted in five of the seven reviewers identifying 11 promising practices and one best practice using the new criteria. These interventions were added to the Portal (which can be accessed at: http://cbpp-pcpe.phac-aspc.gc.ca/).

Throughout the pilot phases, any complex challenges and issues related to the criteria that arose were discussed and debated among the working group; consensus was achieved by the group for each decision made to alter the criteria. Each revision also resulted in improvements in the guidelines accompanying each criterion, the scoring system for the quality of evidence assessment, and the content in the Portal's guidebook for reviewers (a step-by-step guidebook to help reviewers use the screening criteria, which includes examples and additional resources and tools for decision-making). We believe that the most interesting aspects of this work are the issues and challenges we faced in creating these criteria and the definitions we settled on. These issues are presented and discussed in the remainder of this paper.

Results

The final definition of promising practices, based on the pilot test results, is described in Box 1. Table 1 summarizes the key criteria that were developed to distinguish promising practices from best practices, after all the pilot tests. Core criteria, essential for both best and promising practices, are indicated in the merged columns of Table 1.

Table 1 presents the differing criteria for best and promising practices. When using the Portal's screening criteria, the reviewer goes through each criterion one by one to determine if the intervention is: excluded (in which case the review is terminated immediately); a potential promising practice; or, a potential best practice. The last step is to assign numeric scores based on the quality of evidence assessment. The scores vary, depending on the type of study design (ranges from 6 to 19) and are assigned as either rigorous, moderate, or

BOX 1
Definition of promising practices for the Portal

An intervention, program, policy or initiative that shows potential (or 'promise') for developing into a best practice. Promising practices may be in the earlier stages of implementation and/or evaluation.

Promising practices demonstrate:

- **medium-to- impact**: positive changes related to the desired goals must be seen; however, given the potential for future adaptation and growth, this standard is slightly lower than for best practices;
- **high potential for adaptability**: high potential for producing similar positive results in other contexts and settings; this potential is considerably increased when the intervention has a strong theoretical underpinning or logic model;
- **suitable quality of evidence**: as promising practices may be in the earlier stages of evaluation, the quality of evidence is less strict than for best practices.

TABLE 1
Criteria for distinguishing best and promising practices

		Best practice	Promising practice
General criteria	Date	Primary reference article must have been published within the past 10 years	
	Intervention focus	Intervention must address health at a population level; can include interventions at single or multiple levels including individual, community, organization, and societal levels. Clinical interventions are excluded, such as those that focus exclusively on one-on-one treatment recommendations for specific medical diagnoses or drug administration	
	Source	Peer-reviewed article	Grey literature or peer-reviewed article
Impact	Significance of impact	Intervention must rank as moderate to broad impact	Intervention can rank as low impact
	Positive outcomes	Intervention must demonstrate positive outcomes for at least half of the primary objectives of the intervention	
		Intervention must demonstrate: long-term positive outcomes, intermediate outcomes, or short-term positive outcomes appropriate for relevant objectives	Intervention can rank as short-term positive outcomes inappropriate for relevant objectives, or positive outcomes during the intervention implementation period
	Evidence-based grounding	Intervention must be based on evidence-based guidelines/models/standards/theory/evidence-based research/literature/past studies	
Adaptability	Implementation history	Intervention must have been implemented more than twice (the first implementation could have been a pilot)	Intervention may have been implemented only once (may be a pilot)
	Expertise required	The intervention cannot require any specialized skills, or it must require specialized skills that are easily available within the context, or provide specialized training as part of the intervention	The intervention may require specialized skills that are rarely accessible within the context
Quality of evidence	Assessment tool ranking	The evaluation study of the intervention must rank, at minimum, a moderate score, according to the Portal's Quality of Evidence Assessment Tool applied	
		The evaluation study of the intervention must rank as rigorous, according to the Portal's Quality of Evidence Assessment Tool applied	The evaluation study of the intervention can rank as moderate, according to the Portal's Quality of Evidence Assessment Tool applied

limited. The higher the score, the more rigorous the study design.

Discussion

The pilot testing of the Portal's screening criteria for best and promising practices revealed some key challenges and resulted in some in-depth methodological debates that were deliberated by the working group. The following is a list of the challenges we faced and the actions and decisions that were made to address them.

Defining the cut-off points among best, promising, and excluded practices

When defining the criteria for promising practices, a key challenge was to create a thorough ranking system for each of the pre-existing best practices criteria, and then establish new cut-off points that would distinguish between best, promising and excluded practices. In some cases, we found that there were core criteria essential for both best and promising practices (as shown in the merged columns of Table 1), which resulted in having only one cut-off point that would distinguish between best or promising and excluded practices. For example, a core criterion for both a best and promising practice is that the intervention must be based on evidence-based guidelines/models/standards/theory/evidence-based research/literature/past studies. If the intervention does not have this evidence-based grounding, it is automatically excluded from further review and is no longer in the running for either a best or promising practice. Another example of a core criterion is that the intervention must show positive outcomes for at least half of the primary objectives of the intervention. This is the cut-off point for further review and potential inclusion into the Portal as either a promising or best practice.

However, more specific distinguishing features were needed between best and promising practices, so we delved deeper to understand the different types of positive outcomes that can result from health promotion and chronic disease prevention interventions (i.e. different types of positive short-term, intermediate or long-term outcomes). Although this was a challenging process, in the end we were able to define five types of positive outcomes (described below) that help to distinguish between best and promising practices.

We defined *long-term positive outcomes related to primary objectives* as those outcomes that persist one year or more beyond the intervention period; these types of outcomes are associated with best practices. A best practice example of this is a smoking cessation program that has long-term goals to reduce the rates of tobacco use for at-risk youth with an outcome evaluation (conducted upon completion of the program) that showed positive results and a follow-up evaluation (conducted 1.5 years after the completion of the program) with sustained, positive results.

Intermediate outcomes related to primary objectives are those interventions with positive outcomes that persist for a time period between six months and one year beyond the intervention period; these types of outcomes are also associated with best practices. A best practice example of this is a healthy eating program that aims to encourage healthy eating patterns among high school students by providing healthier menu options in the school cafeteria, with an outcome evaluation (conducted seven months after the completion of the program) that showed sustained healthier eating patterns of students, with no further follow-up evaluation studies.

We defined *short-term positive outcomes appropriate for relevant objectives* as those interventions with outcomes that are measured within six months beyond the intervention period that are appropriately related to the short-term nature of the primary objectives; these types of outcomes are also associated with best practices. A best practice example of this is a program that aims to reduce the incidence rates of post-partum depression for new mothers with an outcome evaluation (conducted three months after childbirth) that showed the incidence rates of post-partum depression being lower for program participants than for the control group. For cases like these, a later follow-up evaluation is not appropriate, as a condition such as post-partum depression can only exist within a certain time period.

In summary, interventions with *long-term positive outcomes related to primary objectives*, *intermediate positive outcomes related to primary objectives*, and *short-term positive outcomes appropriate for relevant objectives* are the different types of outcomes that can qualify as a best practice.

We defined *short-term positive outcomes inappropriate for relevant objectives* as those that are measured within six months beyond the intervention period, even though the primary objectives of the intervention are long-term; these types of outcomes are associated with promising practices. A promising practice example of this is a tobacco cessation program that has long-term goals to reduce the rates of tobacco use among at-risk youth, with an outcome evaluation that showed positive results one month after the program is completed. Further evaluation data were not collected to ensure the sustained impact of the program, despite the long-term objectives of the intervention, so it can only be listed as a promising practice.

We defined *positive outcomes during the intervention implementation period* as those that demonstrate positive outcomes during the intervention period itself, but there is not yet a post-intervention follow-up study to show any sustained impact. These types of outcomes are also associated with promising practices. A promising practice example is a mental health promotion program that aims to create a more supportive social environment for adults experiencing depression, with an outcome evaluation about the perceptions of friendships formed during the program that showed positive results. This shows there is some potential for this practice and it can be scored as promising on this criterion.

In summary, interventions with *short-term positive outcomes inappropriate for relevant objectives* and *positive outcomes during the intervention implementation period* qualify only as promising practices and not best practices.

Capturing changes in context as part of adaptability in a way that reviewers can understand consistently

In reality, no intervention can ever be replicated (i.e. implemented in exactly the same way, more than once) because there are always contextual realities that shape the way in which a program is implemented.[9] Thus, drawing the line between a replicated intervention and an adapted intervention is a challenging and complex issue[10] and is one that emerged in the development of the adaptability criteria.

The *Implementation History* criterion examines the adaptability of an intervention by assessing the history of previous implementations. For this criterion, the distinguishing feature between a best and a promising practice is that a best practice has been implemented more than once whereas a promising practice has been implemented only once. In order to meet the best practice criterion, however, each implementation of the intervention must have been substantially the same. We included this additional caveat because although each implementation does need to adapt to its context to some degree, the changes/adaptations made should not be so extensive that they change the fundamental objectives and/or activities of the program itself. If the previous implementations of the intervention are not substantially the same as the others, the program is only considered to be in its first implementation, thus disqualifying it as a best practice (and qualifying it as a potential promising practice only). While this is a very challenging criterion to apply across a wide range of interventions, the criterion outlined above facilitates the review process so that reviewers are not relying solely on their personal judgment and so that interventions are being reviewed as consistently as possible across reviewers.

Handling multiple implementations and evaluation papers on a single intervention

In cases where an intervention is implemented or evaluated more than once, it is common that multiple papers will have been written and published about the intervention (either in a peer-reviewed journal and/or in the grey literature). When assessing an intervention to determine whether it is a best, promising, or excluded practice, the process of reviewing more than one paper against the established criteria is extremely difficult and the process is too onerous for a screening/review process. By attempting to review multiple papers simultaneously, through one set of screening criteria, there is a high risk of reviewers biasing the results by selecting only the positive (or negative) outcomes and characteristics from each of the available studies, and reporting only the most (or least) scientifically sound study design from the available options. This was an important and recurring issue that emerged in the pilot phases and it was decided that reviews should be based on one primary evaluation study document for the intervention under review.

The working group deemed the most important elements required in the primary evaluation study document to be intervention objectives, and evaluation design, methods, and outcomes. In the end, it was determined that if there are multiple evaluation papers on the same intervention, reviewers should select a primary evaluation study document by prioritizing (in this order) the following criteria: (1) it is a peer-reviewed paper; (2) it is a study that shows results from an outcome evaluation study as opposed to a process evaluation study; (3) it includes stronger methods than the other available papers; and (4) it is a more recent publication.

Defining the significance of impact

Throughout the pilot testing phase, we struggled with the significance of impact (previously called magnitude of impact) criterion the most and particularly around related concepts such as magnitude, significance, breadth, and reach of impact. It was challenging to develop a process to assess the level of impact across all types of interventions, especially when intervention target population sizes vary so much from one intervention to another (i.e. community programs versus policies). This type of problem is endemic in that it speaks to the core of the study design, methodology, and reporting conventions of various sub-disciplines and their peers/journals.

In the end, we decided to operationally define this criterion as the proportion of impact, as proportions can be used to effectively gauge the magnitude of impact, despite the type or size of the target population or study. In cases where the proportion is unknown, we relied on looking at the statistical significance of the primary outcomes as a measure of both the breadth and magnitude of the impact. A best practice intervention is required to show moderate to broad impact for this criterion, meaning that the intervention results in positive outcomes in a medium to high proportion ($> 50\%$) of the members of the sample of the target population for which the intervention is designed. In cases where the proportion is unknown, all the primary outcomes must be of medium to large significance (p values < 0.05). Promising practices show low impact for this criterion, meaning that the intervention results in positive outcomes for a small proportion ($< 50\%$) of the sample of the target population for which the intervention was designed. In cases where the proportion is unknown, positive outcomes for at least half (50%) of the primary outcomes need to be significant at a minimal accepted level (p value = .05).

Identifying an expiry date for best or promising practices

Another question that we faced during the pilot phases was the idea of specifying a cut-off or expiry timeframe for an intervention to be considered as a best or promising practice. For example, if an intervention conducted 20 years ago was a best practice then, would it still be considered a best practice today? Would this timeframe be different for promising practices, given that promising practices may eventually become best practices? Do promising practices need to evolve into best practices within a particular amount of time? Does the evaluation study design influence the expiry date of either a best or promising practice?

In thinking through these issues, we reviewed the methodological literature related to evaluation study design types[11,14,16]—including the Portal's Hierarchy of Evidence paper[16]—and we consulted with the working group. Given that most study designs inherently include the context of the intervention within their analysis processes (which, as highlighted by the Hierarchy of Evidence paper, is a critical aspect of any program evaluation), it became clear that after a certain amount of time the context has changed too much for an intervention to be still considered as a best or promising practice.

After applying the screening criteria during the pilot tests, and after discussions with the working group, it was determined that all best practices, including those that had been evaluated using randomized controlled trials (RCT), should expire on the Portal after 10 years (in reference to the date of the most recent evaluation study that was conducted). For promising practices, the logic is different. Given that promising practices may eventually evolve into best practices, regardless of their evaluation study design, they should expire on the Portal more quickly. It was determined that after five years as a promising practice, if the intervention has

not yet evolved into a best practice (in reference to more recent evaluation studies conducted), then it would no longer be a promising practice.

Strengths and limitations

One of the key strengths of this study is that we were able to examine our promising practices screening criteria through three pilot tests, and debate any complex methodological issues that emerged with the working group. This structured process allowed us to develop criteria that have been vetted and are consistent, efficient and manageable when implemented by multiple reviewers. After considerable debate, we also considered policies and legislations to be interventions. We applied the promising practices criteria to these types of interventions as well, and were able to include two provincial school-based policies (one in Nova Scotia and one in Prince Edward Island) as promising practices on the Portal. This has filled a much needed gap of including promising policy and legislative interventions on the Portal.

A limitation is that there is (and likely always will be) tension in developing criteria that are fundamentally academic in nature while also ensuring they are applicable to a wide range of population-level health interventions. It is challenging to systematize a review process for interventions that are so diverse in their objectives, have different target population groups and sizes, apply different types of evaluation study designs, and produce a range of overall outcomes. In any standardized review process, it is necessary to make judgment calls for interventions collectively (that fall into certain categories) as opposed to dealing with each one on a case-by-case basis; however, in doing so, some of the most complex and unique grey areas are often not explored or analyzed in as much depth as they could be. While designing these screening criteria, we realized that if we tried to allow for room to explore the grey areas in a systematic way, we would be introducing too much subjectivity and bias into our review process and that our results would vary too much between reviewers. Thus, the decisions that were made in the development and refinement of the promising and best practices criteria reflect this balance between being able to address the unique circumstances of each intervention and the ability to assess interventions consistently and reliably across reviewers.

Conclusion

The process of systematizing a screening assessment to distinguish among best, promising, and excluded practices was a challenge that raised many complex issues that did not always have clear solutions. Because of the debates that arose throughout our study, we believe that we have defined key features of both best and promising practices that are useful for assessing interventions.

This work provides important insights for practitioners and evaluators to think through when designing a new type of intervention or evaluation study, or adapting/replicating an intervention from a different context. Overall, our intention is to allow for more transparency among practitioners about what works well and what shows promise to work (with whom and under what conditions) within the field of health promotion and chronic disease prevention. We believe that these criteria can be adapted for wide use by decision-makers and public health practitioners.

Acknowledgements

We would like to acknowledge the Promising Practices Working Group here, and thank each of them for their important contributions to this work:

Nina Jetha (Chair): Manager, Canadian Best Practices Initiative, Public Health Agency of Canada

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Conflicts of interest

The authors declare no conflicts of interest.

Authors' contributions and statement

NF, SJ, and NJ all contributed to the study design and the idea for the project. NF took the lead on the interpretation of results, and the writing of the manuscript. SJ provided mentorship to NF during the interpretation of results and writing of the manuscript. All authors (NF, SJ, KW, JY, NJ) informed the data analysis, assisted in the interpretation of results, and critically revised the manuscript and approved the final version.

The content and views expressed in this article are those of the authors and do not necessarily reflect those of the Government of Canada.

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https://doi.org/10.24095/hpcdp.37.11.04

Release notice

Cancer in Young People in Canada: a report from the Enhanced Childhood Cancer Surveillance System

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The Public Health Agency of Canada (PHAC) is pleased to announce the release of *Cancer in Young People in Canada: A Report from the Enhanced Childhood Cancer Surveillance System*. This inaugural report offers a range of measures using data from the Cancer in Young People in Canada (CYP-C) surveillance system. The CYP-C surveillance system collects in-depth data on demographics (date of birth, ethnicity, province and postal code of residence at diagnosis), diagnostic details (date of diagnosis, type of diagnosis, site, stage and metastases at diagnosis), treatments (enrollment on clinical trial and treatment plan details), location and timing of care, and outcomes (hospitalizations, surgeries, complications, relapse, survival) on nearly all children less than 15 years of age diagnosed with cancer in Canada. In the report, results are based on data from 5125 children diagnosed between January 1, 2001 and December 31, 2006 and then followed for up to five years. During this period, childhood cancer was diagnosed at a rate of 152 new cases per million children, an average of approximately 855 cases per year. Overall, five-year survival was 82%. Key statistics on diagnoses, treatments, outcomes and incidence rates by age group and sex are available in the report, accessible at https://www.canada.ca/en/health-canada/services/publications/science-research-data/cancer-young-people-canada-surveillance-2017.html. Researchers interested in studying cancer in children may apply for access to CYP-C data by contacting cypc-ccjc@phac-aspc.gc.ca. The latest surveillance information regarding childhood cancer is available at https://www.canada.ca/en/public-health/services/chronic-diseases/cancer/cancer-children-canada-0-14-years.html.